

OPTIMIZATION OF InGaN/GaN P-I-N SOLAR CELL

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Abstract

InGaN/GaN p-i-n solar cell under AM1.5 illumination using TCAD Silvaco software has been studied. Top p-GaN layer thickness is varied from 5nm to 200 nm and i-InGaN and n-GaN layer thicknesses are varied from 50 nm to 2000 nm and 50 nm to 500 nm respectively. The layer thicknesses of p-GaN and i-InGaN with 25% indium composition are optimized as 20 nm and 200 nm respectively. Doping concentration is varied from 1×10^{16} to $1 \times 10^{19} \text{ cm}^{-3}$ for both p-GaN and n-GaN layers. InGaN based p-i-n solar cell structure with optimized parameters is simulated for open circuit voltage, short circuit current, fill factor and solar cell efficiency.

Lots of interest is generated recently for InGaN based solar cells due its wide band-gap in the entire solar spectrum. P-GaN and i-InGaN layer thicknesses play an important role in solar cell performance. The variation of characteristic parameters of p-i-n solar cell with InGaN layer thickness is shown in Fig.1. The short circuit current is increasing till 200 nm and then remain constant beyond 200nm. The open circuit voltage starts decreasing because recombination is increasing due to higher InGaN thickness.

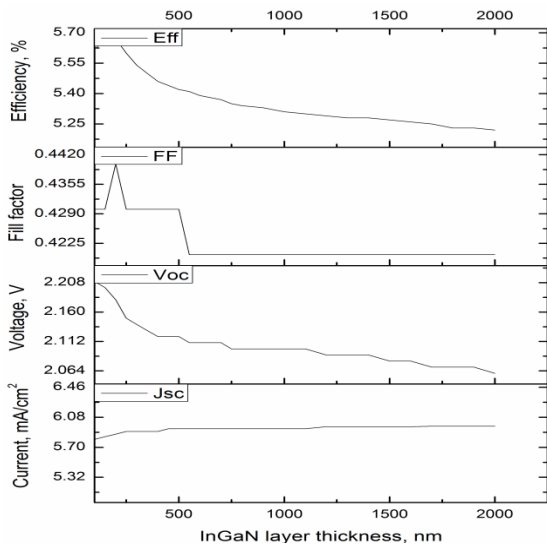


Figure 1: The characteristic parameters of InGaN/GaN solar cell with intrinsic layer thickness

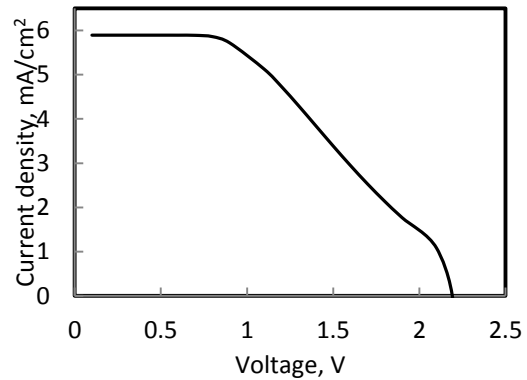


Figure 2: Current-voltage characteristics of optimized p-i-n solar cell.

The optimized InGaN/GaN p-i-n solar cell structure consist of c-plane Sapphire substrate (100 μm), undoped GaN buffer layer (2000 nm), n-type GaN layer (500 nm, $1 \times 10^{18} \text{ cm}^{-3}$), intrinsic InGaN layer (200 nm) and p-type GaN layer (50 nm, $5 \times 10^{17} \text{ cm}^{-3}$). The Indium composition of intrinsic InGaN layer is 0.25. The current – voltage characteristics of optimized p-i-n solar cell is shown in Fig.2. The simulated efficiency achieved is 5.67%.

Reference: Brown G F, Ager III J W, Walukiewicz W, Wu J, *Solar Energy Materials & Solar Cells* **94**478–483, 2010